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(54) An Image Processing Unit and a Storage medium That Stores Control Procedures for the Image Processing Units

(57) [Abstract] (Revised)

[Object] To offer an image processing unit that can acquire without fail an image in which the effects from the defects in the transparency original has been corrected, and a storage medium that stores control procedures for the image processing unit.

[Means for Solving the Problem] This unit has a means for separating the color components of the image of a transparency original into infrared color components, a means for detecting the levels of the infrared components, a means for calculating a correction factor from the infrared component levels, a means for separating said color components of the image of said transparency original into visible components, a means for detecting the levels of the separated visible components, the First means that selects the visible components that correspond to the First area of a part of the transparency original, a means that select said visible components that correspond to the Second area which is a part of the image plane of said transparency original, and is different from the First area, and a correcting process-performing means that applies uniformly the correcting factor that has been calculated by said correction factor-calculating means to both the visible component levels of the First area and the visible component levels of the Second area.

The Structure of an Embodiment of the Image Processing Unit {Translator's note: This diagram is the same as Figure 1}

[Claim]

[Claim 1] An image processing unit characterized by having a separation means for infrared color components that separates the color components of a transparency original image into the infrared components,

a means for detecting infrared components that detects the infrared component levels of said separated infrared components,

a means for calculating a correction factor from said infrared component levels,

a separating means for visible components that separates the color components of said transparency original image into visible components,

a means for detecting visible components that detects the levels of said separated visible components,

First visible component-selecting means that selects said visible components that correspond to the First area, which is a part of said transparency original image plane,

Second visible component-selecting means that selects said visible components corresponding the Second area, which is a part of the image plane of said transparency original, but is different from the First area, and

a correcting means that performs correcting processes by applying uniformly the correcting factor that has been calculated by said correction factor-calculating means to both of said visible component levels of the First area and said visible component levels of the Second area.

[Claim 2] The image processing unit described in Claim 1 wherein the correction factor-calculating means is characterized by the calculation of the correction factor on the basis of the average value of said infrared component levels.

[Claim 3] The image processing unit described in Claim 2 wherein said correction-calculating means calculates said correction factor on the basis of the average value of said infrared component levels from: (the average value of infrared component levels)/(the infrared component level of the pixel to be corrected).

[Claim 4] The image processing unit described in Claim 2 having an additional infrared component-selecting means that selects only the infrared component levels at the threshold value and higher, wherein said correction factor-calculating means calculates said correction factor on the basis of the average value of the infrared component levels selected by said infrared component-selecting means.

[Claim 5] The image processing unit described in Claim 1 characterized by said correction factor-calculating means that calculates said correction factor on the basis of the highest frequency infrared component level that corresponds to the highest frequency level among said infrared component levels.

[Claim 6] The image processing unit described in Claim 5 characterized by said correction

factor-calculating means' calculating said correction factor by calculating (the most frequent infrared component level)/(the infrared component level of the pixel to be corrected).

[Claim 7] The image processing unit described in Claim 1 characterized by having

a means for determining whether the calculation of said correction factor for said transparency original has been finished or not, and, further, by having

a calculation control means which, based on the determination made by said determining means that the calculation for the correction factor has not been finished, orders the correction factor-calculating means to start the calculation.

[Claim 8] The image processing unit described in Claim 7 having, further,

an original-detecting means that detects the insertion of said transparency original into said image processing unit, so that

said calculation control means, based on the original insertion detected by said original-detecting means, will determine that the calculation has not been finished.

[Claim 9] An image processing unit characterized by having

a separating means for infrared components that separates the color components of the transparency original image into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a correction factor-calculating means that calculates for a correction factor on the basis of the average value of said infrared component levels,

a separating means for visible components that separates the color components of the image of said transparency original into visible components,

a visible component-detecting means that detects the visible component levels of said separated visible components, and

a correcting means that performs a correcting process by applying said correction factor obtained through said correcting factor-calculating means to said visible component levels.

[Claim 10] An image processing unit described in Claim 9 wherein said correction factor-calculating means is characterized by calculation for said correction factor on the basis of the average value of said infrared component levels through (the average value of the infrared component levels)/(the infrared component level of the pixel to be corrected).

[Claim 11] The image processing unit described in Claim 9 characterized by having, further,

an infrared component-selecting means that selects only said infrared component levels at

the threshold value and higher, and

said correction factor-calculating means' averaging the infrared component levels selected by said infrared component-selecting means so that the correction factor can be calculated on the basis of the above-calculated average value.

[Claim 12] An image processing unit characterized by having

a separating means for infrared components that separates the color components of a transparency original image into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a correction factor-calculating means that calculates said correction factor on the basis of the most frequent infrared component levels corresponding to the level of the highest frequency in said infrared component levels,

a separating means for visible components that separates the color components of the image of said transparency original into visible components,

a visible component-detecting means that detects the visible component levels of said separated visible components, and

a correcting means that carries out the correction process by applying said correction factor obtained by said correction factor-calculating means to said visible component levels.

[Claim 13] The image processing unit described in Claim 12 characterized by said correction factor-calculating means' calculating said correction factor by calculating, on the basis of said most frequent infrared component level, the (most frequent infrared component level)/(the infrared component level of the pixel to be corrected).

[Claim 14] An image processing unit characterized by having

a separating means for infrared components that separates the color components of the image of a transparency original into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a correction factor-calculating means that calculates said correction factor on the basis of said infrared component levels,

a determining means that determines whether the calculation for said correction factor for said transparency original has been finished,

a calculation-controlling means that makes said correction factor-calculating means start the calculation on the basis of the determination made by said determining means that the calculation for said correction factor has not been finished,

a separating means for visible components that separates the color components of the image of said transparency original into visible components,

a visible component-detecting means that detects the visible component levels of said separated visible components, and

a correcting means that performs a correction process by applying said correction factor calculated by said correction factor-calculating mean to said visible component levels.

[Claim 15] The image processing unit described in Claim 14 having, further,

a transparency-detecting means that detects the insertion of said transparency original into said image processing unit,

characterized by said calculation control means' determining the unfinished calculation on the basis of said original detection means' detection of the insertion of the original.

[Claim 16] A storage medium that stores control procedures for an image processing unit having

a separating means for infrared components that separates the color components of the image of a transparency original into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a separating means for visible components that separates the color components of the image of said transparency original into visible components, and

a visible component-detecting means that detects the visible component levels of said separated visible components,

characterized by storing the correction factor-calculating procedure for the calculation of the correction factor on the basis of said infrared component levels,

the First visible component-selecting procedure for selecting said visible components corresponding to the First area which is a part of the image plane of said transparency original, and

the Second visible component-selecting procedure for selecting a part of said visible component corresponding to the Second area, which is a part of the image plane of said transparency original and is different from said First area,

and the correction procedure for performing the correction process by applying uniformly said correction factor calculated by said correction factor-calculating procedure to both the visible component level for said First area and the visible component for said Second area. the control procedures for the image processing unit described in Claim 16, characterized by said correction factor-calculating procedure's including the procedure of calculating said correction factor on the basis of the average value of said infrared component levels.

[Claim 18] The storage medium that stores control procedures for the image processing unit described in Claim 17, characterized by said correction factor-calculating procedure's including the procedure of calculating said correction factor on the basis of the average value of said infrared component level from: (the average value of infrared component levels)/(the infrared component level of the pixel to be corrected) l.

[Claim 19] The storage medium that stores control procedures for the image processing unit described in Claim 17 characterized by

storing further an infrared component-selecting procedure that selects only the infrared component levels at the threshold and higher, and

said correction factor-calculating procedure's including a procedure wherein the average value of said infrared component levels selected by said infrared component-selecting procedure is calculated so that said correction factor can be calculated on the basis of said average value.

[Claim 20] The storage medium for storing control procedures for the image processing unit described in Claim 16

characterized by the fact that said correction factor-calculating procedure includes the procedure for calculating said correction factor on the basis of the most frequent infrared component level corresponding to the level which is highest in frequency among said infrared component levels.

[Claim 21] The storage medium for storing control procedures for the image processing unit described in Claim 20

characterized by the fact that said correction factor-calculating procedure includes the procedure for calculating said correction factor on the basis of the most frequent infrared component level by calculating: (most frequent infrared component level)/(the infrared component level of the pixel to be corrected).

[Claim 22] The storage medium for storing the control procedures for image processing unit described in Claim 16

characterized by storing further the determining procedure that determines whether the calculation for said correction factor for said transparency original has been finished or not, and

the calculation control procedure that will start the calculation of said correction factor-calculating procedure on the basis of the determination made by said determining procedure that the calculation for said correction factor has not been finished.

[Claim 23] The storage medium for storing control procedures for the image processing unit described in Claim 22

characterized by the fact that said image processing unit has an additional original-detecting means that detect the insertion of said transparent original into said image processing unit, and that

said calculation control procedure includes a procedure that determines, on the basis of the detection of the original inserted by the original-detecting means, that the calculation has not been finished.

[Claim 24] A storage medium that stores control procedures for image processing unit equipped with

a separating means for infrared components that separates the color components of the image of a transparency original into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a separating means for visible components that separates the color components of the image of said transparency original into visible components, and

a visible component-detecting means that detects the visible component levels of said separated visible components,

characterized by storing the correction factor-calculating procedure that calculates a correction factor on the basis of the average value of said infrared component levels, and

a correction procedure that applies said correction factor calculated by said correction factor-calculating procedure to perform a correction process.

[Claim 25] The storage medium storing control procedures for the image processing unit described in Claim 24

characterized by said correction factor-calculating means' calculating for said correction factor by calculating, on the basis of the average value of said infrared component levels, (the average value of the infrared component levels)/(the infrared component level of the pixel to be corrected).

[Claim 26] The storage medium storing control procedures for the image processing unit described in Claim 24

characterized by storing additionally an infrared component-selecting means that selects only those infrared component levels that are at the threshold level and above, and

storing an additional procedure wherein said correction factor is calculated using said correction factor-calculating procedure from the average value of the infrared component levels selected by the infrared component-selecting procedure.

[Claim 27] A storage medium that stores control procedures for an image processing unit equipped with

a separating means for infrared components that separates the color components of the image of a transparency original into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a separating means for visible components that separates the color components of the image of the transparency original into visible components, and

a visible component-detecting means that detects the visible component levels of said separated visible components,

characterized by storing

a correction factor-calculating procedure that calculates a correction factor on the basis of the most frequent infrared component level corresponding to the most frequent level in said infrared component levels, and

a correction procedure that performs the correction process using said correction factor calculated in said correction factor-calculating procedure.

[Claim 28] The storage medium that stores control procedures for the image processing unit described in Claim 27, characterized by the fact that

said correction factor-calculating procedure includes the procedure for calculating said correction factor based on the most frequent infrared component level by using: (the most frequent infrared component level)/(the infrared component level of the pixel to be corrected).

[Claim 29] A storage medium that stores control procedures for an image processing unit equipped with

a separating means for infrared components that separates the color components of the image of a transparency original into infrared components,

an infrared component-detecting means that detects the infrared component levels of said separated infrared components,

a separating means for visible components that separates the color components of the image of said transparency original into visible components, and

a visible component-detecting means that detects the visible component levels of said separated visible components,

characterized by storing

a correction factor-calculating procedure that calculates a correction factor on the basis of said infrared component levels,

a determining procedure that determines whether or not the calculation for said correction factor for said transparency original has been finished,

a calculation control procedure that starts the calculation by said correction

factor-calculating procedure on the basis of the determination by said determination procedure that the calculation has not been finished for said correction factor, and

a correction procedure that performs the correction process by applying said correction factor calculated in said correction factor-calculating procedure to said visible component levels.

[Claim 30] The storage medium that stores control procedures for the image processing unit described in Claim 29 wherein

said image processing unit is additionally equipped with an original-detecting means that detects the insertion of said transparency original into said image processing unit, while

said calculation-controlling procedure includes a procedure that determines an unfinished calculation when the original-detecting means has detected the insertion of an original.

[Detailed Explanation of the Invention]
[0001]
[Technical Field of the Invention] The present invention relates to an image processing unit that detects an image of a transparency original and perform its image-processing, and a storage medium that stores control procedures for the image processing unit.

[0002]
[Prior Art] An image processing unit that read out the image information of a transparency original is composed of the host computer such as a so-called personal computer, and an image reader that is used as an input device of the host computer. Generally a color image is read out by switching three colors: red (R), green (F) and blue (B). The presence of defects such as dust, ink, scratches, and fingerprints on the film original is represented on the read-out surface as black dots (in the case of a positive film) or white dots (in the case of a negative film). They deteriorate the quality of the image.

[0003] To solve this problem, technologies that utilize the characteristics of infrared light to detect on the film original such defects as dust, ink, scratches, and fingerprints. An example of the technologies is found in Japanese Patent 2559970. In this patent gazette, the effects of defects are corrected by detecting the infrared energy distribution intensity. If the detected infrared energy distribution intensity is higher than a designated threshold value, the visible light energy distribution intensity is increased to a level at which the infrared energy distribution intensity is cancelled out. On the other hand, if the detected infrared energy distribution intensity is lower than the designated threshold value, the visible light energy distribution intensity is corrected by interpolation so that the effects of the defects can be corrected.

[0004]
[Problems to Be Solved] The technology that is described in the above-mentioned patent gazette gives only a general idea of the use of infrared ray to correct the effects of defects. It is difficult to obtain an image in which the effects of defects have been corrected. The objective of the present invention is to offer an image processing unit that makes possible to obtain without fail an image in which the effects of defects on a transparency original has been corrected, and offer a storage medium that stores control procedures for such an image processing unit.

[0005]
[Means for Solving the Problems] To solve the above-described problem, the present invention proposes the following unit and storage medium. The unit described in Claim 1 is built so that it has a means for separating the color components of a transparency original image into infrared components, a means for infrared component detection that detects the infrared component levels of the separated infrared components, a correction factor-calculating means that calculates a correction factor on the basis of said infrared component levels, a means for separating the color components of said transparency original image into visible components, a means for detecting the levels of said separated visible components, the First visible component-selecting means that selects the visible components that correspond to the First area, which is a part of the transparency original, the Second visible component-selecting means for selecting the Second area, which is a part of the surface of said transparency original, but is different from the First area, and a correction process-performing means that performs correction processes by applying uniformly the correction factor that has been calculated by said correction factor-calculating means to both the visible component levels of the First area and the visible component levels of the Second area.

[0006] In the unit described in Claim 2, which relates to the image processing unit of Claim 1, the correction factor is calculated from the average value of the infrared component levels. In the unit described in Claim 3 is the image processing unit of Claim 2 wherein the correction factor is calculated by the correction factor-calculating means on the basis of the average value of said infrared component levels from: (the average value of the infrared component levels)/(the infrared component level of the pixel to be corrected).

[0007] The unit described in Claim 4 is the image processing unit described in Claim 2 wherein the unit additionally has an infrared component-selecting means that selects said infrared component levels at the threshold value and higher, and said correction factor-calculating means will calculate the average value of said infrared component levels selected by said infrared component-selecting means so said correction factor can be calculated on the basis of said calculated average value.

[0008] The unit described in Claim 5 is the image processing unit described in Claim 1 operated in such a way that said correction factor-calculating means calculates said correction factor on the basis of the most frequent infrared component level that corresponds to the highest frequency infrared component level of said infrared component levels. The unit described in Claim 6 is the image processing unit described in Claim 5 employed in such a way that said correction factor-calculating means calculates said correction factor from: (the most frequent infrared component level)/(the infrared component level of the pixel to be corrected)

[0009] The unit described in Claim 7 is the image processing unit described in Claim 1 to which a determining means that determines whether said the calculation for said correction factor for said transparency original has been finished or not, and a calculation control means which, upon said determination means' determination that the calculation for said correction factor is not finished, will make said correction factor-calculating means start the calculation.

[0010] The unit described in Claim 8 is the image processing unit described in Claim 7

with the addition of an original-detecting means that detects the insertion of said transparency original so that the unfinished calculation will be determined by said calculation control means when said original detection means has detected the original insertion.

[0011] The unit described in Claim 9 has a separating means that separates the color components of the image of a transparency original into infrared components, an infrared component-detecting means that detects the infrared component levels of said separated infrared components, a correction factor-calculating means that calculates a correction factor on the basis of the average of said infrared component levels, a separating means that separates the color components of the image of said transparency original into visible components, a visible component-detecting means that detects the visible component levels of said separated visible components, and the correcting means that performs a correction process by applying said correction factor, which has been calculated by said correction factor-calculating means, to said visible component levels.

[0012] The unit in Claim 10 is an image processing unit described in Claim 9 wherein said correction factor is calculated by said correction factor-calculating means on the basis of the average value of said infrared component levels from: (average value of infrared component levels)/(infrared component level of the pixel to be corrected). The unit of Claim 11 is an image processing unit described in Claim 9 with an additional infrared component-selecting means that selects only said infrared component levels that are at the threshold level and higher so that the average value of said infrared component levels selected by said infrared component-selecting means can be calculated and the calculated average value can be used to calculate said correction factor.

[0013] The unit in Claim 12 has a separating means that separates the color components of the image of a transparency original into infrared components, an infrared component-detecting means that detects the infrared component levels of said separated infrared components, a correction factor-calculating means that calculates said correction factor from the most frequent infrared component level that corresponds to the highest frequency level of said infrared component levels, a separating means that separates the color components of the image of said transparency original into visible components, a visible component-detecting means that detects the visible component levels of said separated visible components, and a means for correction that performs a correction process by applying said correction factor calculated by said correction factor-calculating means to said visible component levels.

[0014] The unit of Claim 13 is the image processing unit described in Claim 12 wherein said correction factor-calculating means calculates said correction factor on the basis of the most frequent infrared component level using (most frequent infrared component level) /(the infrared component level of the pixel to be corrected). The unit of Claim 14 has a separating means that separates the color components of the image of the transparency original into infrared components, an infrared component-detecting means that detects the infrared component level of said separated infrared components, a correction factor-calculating means that calculates said correction factor from said infrared component levels, a determining means that determines whether the calculation for said correction factor for said transparency original has been finished, a calculation control means that makes said correction factor-calculating means start the calculation when said determining means has determined that the calculation for said correction factor has not been finished, a

separating means that separates the color components of the image of said transparency original into visible components, a visible component-detecting means that detects the visible component levels of said separated visible components, and a correcting means that performs a correction process by applying said correction factor calculated by said correction factor-calculating means to said visible component means.

[0015] The unit of Claim 15 is the image processing unit described in Claim 14 which additionally has an original detection means that detects the insertion of said transparency original into said image processing unit, and based on this original insertion detection by said original detection means, said calculation control means determines the unfinished calculation.

[0016] The storage medium of Claim 16 is a storage medium that stores control procedures for an image processing unit that has a separating means that separates the color components of the image of a transparency original into infrared components, an infrared component-selecting means that detects the infrared component levels of said separated infrared components, a separating means that separates the color components of the image of said transparency original into visible components, and a visible component-detecting means that detects the visible component levels of said separated visible components. This storage medium stores the correction factor-calculating procedure that is for calculating a correction factor from said infrared component levels, the First visible component-selecting procedure that selects said visible components that correspond to the First area, which is a part of the plane of said transparency original, the Second visible component-selecting procedure for selecting said visible components that correspond to the Second area, which is a part of the surface of said transparency original, but is different from said First area, and a correction procedure for the performance of the correction process by applying uniformly said correction factor calculated by said correction factor–calculating procedure to both the visible component levels in said First area and the visible component levels in said Second area.

[0017] The storage medium of Claim 17 is based on the storage medium that stores the control procedures for the image processing unit described in Claim 16, wherein said correction factor-calculating procedure includes the procedure for calculating said correction factor from the average value of said infrared component levels. The storage medium of Claim 18 is a storage medium that stores the control procedures for the image processing unit described in Claim 17, and includes the procedure for calculating said correction factor from the average value of said infrared component levels, using: (average value of infrared component levels)/(infrared component level of the pixel to be corrected).

[Claim 18] The storage medium of Claim 19 is based on the storage medium that stores the control procedures for the image processing unit described in Claim 17, which stores further an infrared component-selecting procedure that selects only those infrared component levels at threshold value and higher. The average value of said infrared component levels selected above is calculated in said correction factor-calculating procedure, and the calculated average value then is used to calculate said correction factor.

[Claim 19] The storage medium of Claim 20 is the storage medium that stores the control procedures for the image processing described in Claim 16, in which said correction factor-calculating procedure includes a procedure for calculating said correction factor from

the most frequent infrared component level corresponding to the highest frequency level of said infrared component levels.

[Claim 20] The storage medium of Claim 21 is a storage medium that stores control procedures of the image processing unit described in Claim 20 wherein said correction factor-calculating procedure includes the procedure for calculating said correction factor from said most frequent infrared component level using: (most frequent infrared component level)/(the infrared component level of the pixel to be corrected).

[Claim 21] The storage medium of Claim 22 is a storage medium that stores control procedures for the image processing unit described in Claim 16, wherein there is a determining procedure that determines whether the calculation for said correction factor for said transparency original has been finished or not. The storage medium also stores a calculation control procedure that makes said correction factor-calculating procedure start when an unfinished calculation for correction factor is determined by said determination procedure.

[Claim 22] The storage medium of Claim 23 is a storage medium that stores control procedures for the image processing unit described in Claim 22, wherein said image processing unit has an original-detecting means that detects the insertion of said transparency original into said image processing unit, and upon the detection of the original insertion by the said original detection means, said calculation control procedures determines that the calculation is unfinished.

[Claim 23] The storage medium of Claim 24 is a storage-medium that stores the control procedures of an image processing unit having a separating means that separates the color components of the image of a transparency original into infrared components, an infrared component-detecting means that detects the infrared component levels of said separated infrared components, a separating means that separates the color components of the image of said transparency original into visible components, and a visible component-detecting means that detects the visible component levels of said separated visible components. Stored in this storage medium are a correction factor-calculating procedure for calculating a correction factor from the average value of said infrared component levels, and a correction procedure that performs a correction process by applying said correction factor calculated through said correction factor-calculating procedure to said visible component level.

[0024] The storage medium of Claim 25 is a storage medium that stores control procedures for the image processing unit described in Claim 24 wherein said correction factor-calculating procedure includes a procedure for calculating said correction factor on the basis of the average value of said infrared component levels using: (average value of infrared component levels)/(infrared component level of the pixel to be corrected)

[0025] The storage medium of Claim 26, which stores control procedures for the image processing unit described in Claim 24, stores additionally an infrared component-selecting procedure that selects only said infrared component levels at and higher than the threshold value, and said correction factor-calculating procedure additionally contains a procedure that calculates the average value of the infrared component levels selected by said infrared component-selecting procedure and calculate said correction factor from the calculated said average value.

[0026] The storage medium of Claim 27 stores control procedures for an image processing unit having a separating means that separates the color components of the image of a transparency original into infrared components, an infrared component-detecting means that detects infrared component levels of said separated infrared components, a separating means that separates the color components of the image of said transparency original into visible components, and a visible component-detecting means that detects visible component levels of said separated visible components, and stores a correction factor-calculating means that calculates a correction factor from the most frequent infrared component level that corresponds to the level of the highest frequency of said infrared component levels, and a correction procedure that performs a correction process applying said correction factor calculated through said correction factor-calculating means to said visible component levels.

[0027] The storage medium of Claim 28 is a storage medium that stores control procedure for the image processing unit described in Claim 27 wherein said correction factor-calculating procedure includes a procedure for calculating a correction factor from said most frequent infrared component level using: (the most frequent infrared component level/(infrared component level of the pixel to be corrected).

[0028] The storage medium Claim 29 is a storage medium that stores control procedures for an image processing unit that has a separating means that separates the color component of the image of a transparency original into infrared components, an infrared component-detecting means that detects the infrared component levels of said separated infrared components, a separating means that separates the color components of the image of said transparency original into visible components, and a visible component-detecting means that detects the visible component levels of said separated visible components. This storage medium stores a correction factor-calculating procedure for calculating a correction factor from said infrared component levels, a determining means that determines whether the calculation for said correction factor for said transparency original has been finished or not, a calculation-controlling procedure which, based on the determination by said determination procedure that the calculation for said correction factor has not been finished, makes said correction factor-calculating procedure start the calculation, and a correction procedure for executing a correction process by applying said correction factor calculated by said correction factor-calculating procedure to said visible component level.

[0029] The storage medium of Claim 30 is a storage medium that sores control procedures for the image processing unit described in claim 29 which additionally has a transparency-detecting means that detects the insertion of said transparency original into said image processing unit, and said calculation control procedure contains a procedure that determines an unfinished calculation based on the detection of original insertion by the original detection means.

[0030]
[Embodiments of the Invention] Hereafter the first embodiment of the present invention will be explained with reference to drawings. Figure 1 is a drawing that shows the configuration of an image processing unit. Figure 2 is a diagram showing how the film original is arranged. The image processing unit is composed of host computer 1 and image reader 2. host computer 1 is equipped with a central processing unit (hereafter "CPU") 1a, memory 1b, and HDD (hard disk drive) 1c. host computer 1 is also equipped with a CD-ROM drive so that a CD-ROM can be loaded. The CD-ROM is a storage medium in

which various programs and data are stored. host computer 1 is equipped with a keyboard, a mouse, and other input devices as well as a display device, although they are not shown in the drawing.

[0031] The image reader 2 is equipped with CPU 11, motor drive circuit 12, motor drive circuit 28, LED-driving circuit 13, signal processing circuit 14, ROM 15, RAM 16, interface circuit (hereafter "I/F circuit") 17, line sensor 18, A/D converter 19, vertical scanning mechanism motor 20, focus adjusting motor 27, lighting device 21, reflective mirror 22, reflective mirror 23, toric mirror 24, lens 25, and the carrying path for film original 26. Image reader 2 is connected to host computer 1 via I/F circuit 17.

[0032] CPU 11 is a circuit that performs the control of various parts and calculation processes. The lighting device 21 has R-LEDs, G-LEDs, B-LEDs and IR-LEDs, each color LEDs in plurality of number. an R-LED is a light-emitting diode that emits a red wavelength light (R light). a G-LED is a light-emitting diode that emits a green wavelength light (G light), B-LED is a light-emitting diode that emits a blue wavelength light (B light), IR-LED is a light-emitting diode that emits an infrared wavelength light (IR light). LED drive circuit 13 is a circuit that drives lighting device 21. LEDs of various colors of lighting device 21 emit light by means of the driving signals of LED driving circuit 13.

[0033] The light emitted from lighting device 21 is reflected by toric mirror 24 and reflective mirror 21, and the light is projected to the lighted point P. The film original 26, which is on the lighted point P, is lighted in lines. As shown in Figure 2, film original 26 is composed of film original section 26a and film mount section 26b. Film original section 26a is a 35 mm photographic film. The film mount section consists of 2 plates that hold film original section 26a in between. Original holding base 36 is a base that holds film 26. Film hold-down spring 33 is a flat spring that holds film original 26 against original holding base.

[0034] Reflective mirror 23 and lens 25 composes an imaging optical system. Reflective mirror 23 serves for turning in the optical path of the light having passed through film original 26 in the direction of lens 25. In other words, reflective mirror 23 turns in the optical axis 35 of lens 25. Lens 25 forms the image of lighted point P on line sensor 18.

[0035] Line sensor 18 has plurality of photoelectric converters, and plurality of electric charge transfer sections. The photoelectric converters are arranged in lines. Hereafter, the direction in which the photoelectric converters are arranged will be called horizontal scanning direction. In Figure 1, the horizontal scanning direction is the direction perpendicular to the page surface. The photoelectric converters, in accordance with the accumulation time set at CPU 11, converts the quantity of light they receive to analog image signals of approximately proportionate amount of voltage. The analog image signals are output through the electric charge transfer sections to A/D converter 19. The accumulation time for the photoelectric converters of line sensor 18 may be controlled by the lighting time of the lighting device.

[0036] A/D converter 19 converts the input analog image signal to digital image data and outputs the data to signal processing circuit 14. A/D converter 19 is an 8 bit A/D converter. With the minimum value being 0 and the maximum value being 256, it is capable of outputting 256 digital tone levels. Hereafter, a value in digital image data is called the luminance level. Film original 26 is color-separated into colors lighted by lighting device

21. Hereafter, the digital image data obtained during R light illumination will be called the R image data.
The digital image data obtained during G light illumination will be called the G image data.
The digital image data obtained during B light illumination will be called the B image data.
The digital image data obtained during IR light illumination will be called the IR image data.

[0037] The luminance level of the R image data will be called R luminance level. The luminance level of the G image data will be called G luminance level. The luminance level of the B image data will be called B luminance level. The luminance level of the IR image data will be called IR luminance level. Signal processing circuit 14 performs the processing of digital image data based on the instruction from CPU 11. The processed digital image data are stored in RAM 16. The program that shows the control procedures that CPU 11 carries out is stored in ROM 15. Later, this program will be described in detail.

[0038] I/F circuit 17 is an interface circuit employed in the communication with host computer 1. I/F circuit 17, upon receiving an instruction from CPU 11, outputs the digital image data stored in RAM 16 to host computer 1. I/F circuit 17 also receives instructions from host computer 1 and passes them to CPU 11. Furthermore, I/F circuit 17 transfers the state of scanner and the like outputted by CPU 11 to host computer 1.

[0039] Vertical scanning mechanism 29 is a mechanism that moves original-holding base 32 in the vertical scanning direction. The vertical scanning direction is a direction perpendicular to the horizontal direction. The vertical scanning direction is perpendicular to optical path 35 of lens 25 where it crosses the original. In Figure 1, the vertical scanning direction shown in Figure 1 is a directions running right to left and left to right on the surface of the page. Vertical scanning mechanism 29 is composed of trains of gears. Motor drive circuit 12, upon receiving an instruction from CPU 11, outputs a motor-driving signal to vertical scanning mechanism motor 20 .The motor-driving signal is a signal that indicates the direction and amount of the rotation of vertical scanning mechanism motor 20. Vertical scanning mechanism motor 20 drives vertical scanning mechanism 29 by the motor-driving signal.

[0040] The focus-adjusting mechanism 30 is a mechanism that moves the original-holding base 32 in the focus-adjusting directions. The focus-adjusting directions are the directions of optical axis where it intercepts film original 26 (that is, the up-down directions on the page that shows Figure 1). Focus-adjusting mechanism 30 is composed of gear trains. Motor driving circuit 28 receives instructions from CPU and outputs motor driving signals to focus-adjusting motor 27. The motor driving signals are the signals that indicate the directions and amount of the rotation of focus-adjusting motor 27. The focus adjusting motor 27 drives focus adjusting mechanism 30 in accordance with motor driving signals.

[0041] After host computer 1 has acquired digital image data, it determines from the IR image data whether there are defects such as dust, particles, scratches and fingerprints on film original 26. Upon detecting the presence of defects, host computer 1 uses IR image data to correct the R image data, G image data and B image data at the points where the defects are present. CPU 11 can also perform the correction.

[0042] The method for detecting whether film original 26 is mounted to image reader 2 or not will be explained below with reference to Figures 2 through 4. Figures 3 and 4 are

flowcharts showing the original-detection procedure. The programs shown in Figures 3 and 4 are stored in ROM 15. Figure 2 illustrates the state in which film original 26 is placed on original-holding base.

[0043] While image-reading is not in operation, original holding base 32 is in a specific position. While image reader 2 is in standby, line sensor 18 periodically reads line sensor 1 image and compare luminance levels of the digital image data with the previously set threshold value L3. Threshold value L3 is set so that it can determine whether film original 26 has been mounted or not.

[0044] The "specific position" should be the position either film mount section 26b or original section 26a is found when film original 26 is mounted. For example, the specific position is where the position of X1 in Figure 2 agrees with lighting point P. While film original 26 is not mounted, the "specific position" should be in an optically plain (see-through) state.

[0045] On CPU 11, the accumulation time for line sensor 18 is set so that the output from A/D converter 19 will be in full scale value at the optically plain state. When line sensor 18 are on the location corresponding to film mount section 26b or film original section 26a, the quantity of light that line sensor 18 receives is lower than it does in the optically plain state because the light is screened by film mount section 26b or film original section 26a. As a result, the output from A/D converter is lower. The degree of the decrease in output of A/D converter varies depending on what screens line sensor 18. For example, in case of film mount section 26b, the screening of light is complete, and the output from A/D converter 19 is the lowest. In the present embodiment, A/D converter 19's reference voltage is set so that A/D converter 19 will output 0. In this setting, the output range of A/D converter 19 is effectively utilizable.

[0046] With film original section 26a is in between, the transmitted quantity of light changes depending on the density of film original 26a, and the output of A/D converter 19 changes with the density of the film original. The density of film is the lowest in the base area of a reversal film, at about 90 percent of the plain area. The threshold value L3 in the present embodiment, given some marginal value, should be set at 95% of the plain area.

[0047] The flowchart in Figure 3 starts when the power source switch is turned on at image reader 2. At S1, CPU 11 drives vertical scanning mechanism motor 20 to move the X0 line on original holding base 32 to lighted point P. The light from illuminating device 21, whether film original 26 has been mounted or not, passes through the plain area 34 and reaches line sensor 18.

[0048] At S2, CPU 11 controls line sensor 18 and have it perform line-1 read-out for accumulation time T'. Assume that A/D converter 19 output value at the time is L. Next, CPU 11 calculate for accumulation time T at line sensor 18 at which the output from A/D converter is at full scale value. The specific formula at the calculation is as follows:

$$T = T' \times (255/L)$$

At S3, CPU 11 drives vertical scanning mechanism motor 20 to move X1 line of original holding base 32 to lighting point P.

[0049] At S4, CPU 11 controls line sensor 18 to have it perform the read-out of line-1 for accumulation time T. At S5, CPU 11 calculates L1, the average output power for line-1 at line sensor 18. At S6, CPU 11 compares average value L1 calculated at S5 with the previously set threshold value L3.

[0050] At S7, CPU 11 proceeds to S8 if the result of comparison at S6 indicates that the average value L1 is greater than threshold value L3. If L1 is found to be lower than L3, the process proceeds to S9. At S8, CPU 11 sets the flag F1 to be 0, and proceeds to S10. Flag F1 is a flag that stores the information as to whether film original 26 has been mounted or not. If flag F1 is 0, it means film original 26 is not mounted. If Flag F1 is 1, it means that film original 26 has been mounted.

[0051] At S9, CPU 11 sets flag F1 to be 1, and proceeds to S10. At S10, CPU 11 resets the elapsed time, and starts the measurement of a new elapsed time. A timer in CPU 11 performs the measurement of elapsed time. In S11, which is indicated in Figure 4, CPU 11 recognizes that it has received an instruction from host computer 1, and advances the process to S13. If CPU 11 decides that it has not received any instruction from host computer 1, it proceeds to S12.

[0052] At S12, CPU 11 returns to S3 if it has determined that the duration of measurement time started at S10 reached to a designated time. If it has decided that the time being measured has not reached the designated limit, CPU 11 returns to S11. In setting the above-mentioned designated time, a standard time required for the user to remove a film original out of image reader 2 and then insert it back to the reader is assumed to be the reference time, and the designated time is set to be a time shorter than this reference time. CPU 11, for example, set the elapsed time to be about two seconds.

[0053] At S13, when CPU 11 has decided that an instruction from host computer 1 relates to whether film original 26 is mounted or not, it advances to S16. If CPU 11 has decided that the instruction does not concern whether the film original is mounted or not, it proceeds to S 14. At S14, CPU 11 analyzes the instruction from host computer 1, and performs at S15 a process in response to the instruction. The process here includes the reading of the image. After the process of S15 has been finished, CPU 11 returns the process to S11.

[0054] At S16, CPU 11 advances the process to S17 if it determines that flag F1 is 0. If it determines that flag F1 is 1, it advances the process to S18. At S17, CPU 11 sends a message to host computer 1 saying that film original 26 has not been mounted, and then advances the process to S19.

[0055] At S18, CPU 11 sends a message to host computer 1 and let it know that film original 26 has been mounted, and proceeds to S19. At S19, upon determining that the power source of image reader 2 has been switched off, CPU 11 terminates the flowchart process. When CPU 11 has determined that the power source of image reader 2 has not been switched off, it returns the process to S11.

[0056] Hereafter, the correction process of Embodiment 1 will be explained with reference to Figures 5 through 25. Figure 5 is a drawing illustrating the digital image data. Figures 6 and 7 explain the principle of digital image data correction process. Figures 8 through 17

are flowcharts for the correction process procedures to be performed by the host computer. Figures 18—21 illustrate the aligning process. Figures 22—25 are process procedures for CPU 11 to perform.

[0057] Referring to Figures 5—7, the principle of digital image data correction process will be explained below. The reading of the image of film original 26 can be done by the line sequential system, in which the reading is carried out line by line, switching between four colors, and the frame-sequential system in which one whole image is read out in one color at a time, switching colors one after another until four colors are read. In either case, stored in RAM 16 are four types of data—R image data, G image data, B image data and IR image data.

[0058] The four types of data are different from each other in the following manner. R image data, G image data and B image data relate to visible light corresponding to red (R) component, green (G) component and blue (B) component, respectively. In other words, these data show luminance information related to film original 26. Thus, in film original 26, higher the density in an area is, less light is allowed to transmit through the area. The value for digital image data (that is, luminance level), therefore, is smaller. On the other hand, the lower the density is on an area of film original 26, more light is likely to transmit the area, and, therefore, the digital image data value (luminance level) is higher.

[0059] Shown in Figure 5(a) is a dust speck 70 on film original 26. Shown in Figure 5(b) is digital image data of film original 26 displayed. Shown Figure 5(c) is the distribution of luminance levels of digital image data. The dust speck 70 adhering to line Xm on Film Original 26 has an effect on digital image data because Speck 70 on Film Original 26 blocks illuminating light. The quantity of light that reaches line sensor 18 is less because of this blocking of light. The digital image data in the area where dust and the like are present indicate as if there were a high density state on Film Original 26. In other words, there is an Area 40 in which digital image data has decreased as indicated in Figure 5(c).

[0060] In addition, on an area in the line sensor 18, which corresponds to the peripheral area of the dust speck, the light arriving at the area increases. This could be interpreted to be the effect of light diffraction in the area around the dust speck. Therefore, the digital image data in the peripheral area around dust and the like will present a state as if Film Original 26 was in a low-density state. There are Areas 41 and 42 where digital image data has increased.

[0061] In addition, Figure 5(c) shows Data 43, where the density values of picture design have caused changes in luminance levels. As described previously, in such data as R image data, G image data and B image data, the "luminance levels due to the increase or decrease of transmitted light" overlaps the "luminance levels that correspond to the proper density of the film original."

[0062] Film Original 26 is innately low in IR reception sensitivity. For that reason, the light quantity of IR light that passes Film Original 26 is hardly affected by the density of Film Original 26. Therefore, the IR image data obtained by using an IR illuminating light has almost consistently the same value for whatever film original being in use. However, if there are dust or scratches on Film Original 26, the light that reaches Line sensor 18 will increase or decrease due to the effect of these dust or scratches, causing IR image data to become affected by these defects. Thus, IR image data also have Decreased Area 40, and

Increased Areas 41 and 42. In short, among IR image data, those whose values has increased or decreased reflect the "luminance levels for increase or decrease of transmitted light caused by dust, scratches, and the like."

[0063] In Figures 6 and 7, if there is no defect on Film Original 26, the luminance level of IR image data will show a certain constant value (the reference value). On the other hand, the luminance levels for R image data, G image data and B image data reflect the original's density. If there is a defect on Film Original 26, the luminance levels show a decrease in luminance level at this defect, as shown in Figure 6. In Figure 7, luminance level shows an increase at the location of the defect. In Figure 6, the IR luminance level (IR') at the defect is higher than the IR luminance level (IR) in the area where there is no defect. Therefore, the ratio (IR/IR') should indicate the ratio of increase or decrease at the defect. The setting of IR luminance level (IR) in the case where there is no defect will be described later.

[0064] Regarding IR luminance level on Film Original 26, let us consider a case in which IR luminance level, which has increased or decreased from the reference value (IR') has been detected. If the IR luminance level was multiplied by (IR/IR'), a correction factor which is the ratio between IR and IR', IR luminance level (IR) can be obtained. The luminance levels for digital image data of visible light also increase or decrease at the same ratio as that of IR luminance level. Therefore, multiplying R luminance level (R'), G luminance level (G'), and B luminance level (B') by correction factor (IR/IR') will be able to correct the effects of the defect at the luminance levels of these colors. As shown in Figures 6 and 7, the process is able to reproduce the R luminance level (R), G luminance level (G), and B luminance level, the levels for the defect free state.

[0065] This correction process, however, can be effective only when R image data, G image data and B image data contain some information of defect-free state. If IR' luminance level, which is a factor of ratio (IR/IR'), is too low, the ratio cannot be used to correct the R image data, G image data and B image data. If the luminance level of IR' is lower than the set threshold value, it is expected that the simple multiplication of ratio (IR/IR') will not correct these image data.

[0066] This correction problem can be solved by using the following interpolation process. In general, the area occupied by a speck or scratch is not very large. Within the area, a density difference (that is, a pattern) is less likely to be present. It is more likely that the area does not have any pattern change. In the area specified by the presence of dust or a scratch, you can use the data on both sides of the area, and smooth the transition. In this manner, the image of Film Original 26 can be corrected without creating any irregular impression.

[0067] The above-explained correction, which is performed as a joint operation between host computer 1 and image reader 2, will be specifically explained below in two parts, the process procedure in host computer 1 and the process procedure in CPU 11 of image reader 2. First, the process procedure in host computer 1 will be explained with reference to Figures 8—17; and then the CPU 11 process procedure in image reader 2 will be explained with reference to Figures 22—25.

[0068] The program shown in Figures 8—17 flowcharts is stored in a CD-ROM so they can be set up in host computer 1. The program set up is stored in HDD 1c. The program, read into memory 1b, is used by CPU 1a. The program shown in Figures 22—25 flowcharts is

stored in ROM 15. The program, as it is read into RAM 16, is used by CPU 11.

[0069] (A) host computer 1 Process Procedure

Figure 8 flowchart will start when the user starts up the image reader process program using the input device of host computer 1. At S401, an instruction is sent to Image Reader 2 asking whether film original 26 is present or not. image reader 2, as explained previously (Figures 3 and 4), detects whether film original 26 is present or not, and sent the response to host computer 1.

[0070] At S402, it is determined whether the response from image reader 2 is saying the original is present or not. host computer 1, which has received a response "Original is present," decides YES, and proceed to S403. On the other hand, host computer 1, upon receiving a response "Original is absent," decides NO at S402, and proceeds to S 408. At S408, host computer 1 sets flag F2 to 0. F2 = 0 indicates that film original 26 has not been mounted. F2=1 indicates that film original 26 has been mounted. Because flag F2 is initialized when host computer 1 starts image reading process program, F2 = 0 at the first image reading operation. Incidentally, flag F2 is stored in Memory 1b.

[0071] At S403, host computer 1 decides whether the user has issued a scan instruction or not. If the answer is determined to be YES at S403, process proceeds to S404. If answer No is determined, process goes back to S401. At S404, whether flag F2 has been set to 0 or not is decided. When host computer 1 has decided that flag F2 = 0 at S404, the process proceeds to S405. At S405, Flag F2 is set to 1. At S406, Flag F3 is set to 1. At S404, if host computer 1 has decided that flag F2 = 1, the process proceeds to S407.

[0072] The state F3 = 1 means that the state of the absence of film original 26 has changed to the state of the presence of film original 26. F3 = 0, on the other hand, means that the calculation for the First IR luminance level has been finished for currently mounted film original 26. The First IR luminance level will be explained later. In S407, host computer 1 determines whether flag F3 is 1 or not. If Flag 3 is 1, the process proceeds to S410. If Flag F3 is 0, the process proceeds to S430 without performing prescanning.

[0073] In S410, host computer 1 sends the prescan start instruction to image reader 2. Image reader 2, in Figures 22—25 (to be described later), carries out prescanning, and sends the digital image data to host computer 1. The digital image data consists of R image data, G image data, B image data and IR image data.

[0074] In S411, host computer 1 waits until it completes the reception of all the digital image data from image reader 2. Upon completing the reception of all the digital image data, host computer 1 determines YES at S411, and proceeds to S412. At S412, host computer 1 detects out of the received digital image data the maximum luminance level of R image data, R_{max}, the maximum luminance level of G image data, G_{max}, and the maximum luminance level of B image data, B_{max}. Next, host computer 1, in S413, determines whether the mounted film is a positive film or not.

[0075] If the film was positive, host computer 1 decides YES at S413, and proceeds to S414. If the film was negative, host computer 1 decides NO at S413 and proceeds to S419. Process S414—S418 and Process S419—S424 are the processes that set the accumulation time at line sensor 18 for preview scanning or main scanning.

[0076] 1) The Case of a Positive Film

At S414, host computer 1 selects the largest of R_{max}, G_{max} and B_{max} that were obtained in S412. This is set as Visible $Light_{max}$. At S415, host computer 1, in order to set Visible $Light_{max}$ in the neighborhood of A/D converter 10 full-scale, calculates the scale factors for RGB multiplications. If A/D converter 19 is in 8-bit, the full scale should be 255, and so RGB scale factor = 255/visible $light_{max}$ should be calculated.

[0077] In S416, host computer 1 detects IR_{max}, the maximum luminance value of the IR image data it has received. In S417, to set IR_{max} near the full scale of A/D converter 19, IR scale factor is calculated. If A/D converter 19 is in 8 bit, a calculation of IR scale factor = $255/IR_{max}$.

[0078] In S418, host computer 1 multiplies prescan accumulation times Tr', Tg', Tb', and Tir' by their respective scale factors so that Tr, Tg, Tb, and Tir, which are the accumulation times in preview scan or main scan can be set. In other words, in S418, host computer 1 executes the following calculations, and then proceeds to S425.

Tr = Tr' x RGB scale factor
Tg = Tg' x RGB scale factor
Tb = Tb' x RGB scale factor
Tir = Tir' x IC scale factor

2) The Case of a Negative Film

[0079] In this case, to set each of R_{max}, G_{max}, and B_{max} in the neighborhood of the full scale of A/D converter 19, their respective scale factors are calculated. In S419, host computer 1 calculates R scale factor = $255/R_{max}$ on the basis of R_{max} it calculated in S412. In S420, host computer 1 calculates G scale factor = $255/G_{max}$ on the basis of G_{max} it calculated in S412. In S421, host computer 1 uses B_{max} it calculated in S412 to calculate B scale factor = $255/B_{max}$.

[0080] At S422, host computer 1 detects IR_{max}, the maximum luminance value of the IR image data it has received. At S423, to set IR_{max} near the full scale of A/D converter 19, host computer 1 calculates IR scale factor. It calculates IR scale factor = $255/IR_{max}$, and proceeds to S424. In S424, host computer 1 multiplies the prescan accumulation times Tr', Tg', Tb', and Tir' by their scale factors to set the accumulation times Tr, Tg, Tb, and Tir for preview scan or main scan. Thus in S424, host computer 1 executes the following calculations and then proceeds to S425.

[0081] Tr = Tr' x R scale factor
Tg = Tg' x G scale factor
Tb = Tb' x B scale factor
Tir = Tir' x IR scale factor

In S425 next, host computer 1 sends image reader 2 accumulation times Tr, Tg, Tb, and Tir it has calculated with a preview scan start instruction. Image reader 2 then performs a preview scan to read images. During S426 next, host computer 1 waits until the transmission of all the digital image data from image reader 2 is completed.

[0082] After the reception of all the preview scan image data from image reader 2, host computer 1 decides YES in S426, and proceeds to S427. At S427, host computer 1, based on the digital image data received in S426, displays the image on the screen. In S428, it initializes variable S to 0. Variable S and n are stored in memory 1b so that the average value of IR luminance levels can be calculated from them as will be explained later.

[0083] Next, in S431—S436, IR luminance level (the First IR luminance level) is calculated as a reference value. The First IR luminance level should be close to the IR luminance level for the defect-free state. In this calculation, it is assumed that the area of defects on the original should be small. Based on this assumption, the average value of IR luminance level is calculated as the First IR luminance level. However, the inclusion of pixels for dust where the levels will be markedly lower in the calculation will increase the error. To avoid this problem, a threshold value (the Second IR luminance level), which is outside the range of IR luminance level scattering that can be caused by the difference in the film and subject types, is set up. Those pixels that do not reach the Second IR luminance level are not to be used in the calculation for the First IR luminance level. In S430, the following specific procedure is used to determine the Second IR luminance level.

[0084] To begin with, IR_{max}, the maximum luminance level of the IR image data received in S426, is detected. Next, IR_{min}, the minimum luminance level of the IR image data received in S426, is detected. The Second IR luminance level, then is calculated from the following formula:

Second IR luminance level = $(IR_{max} + IR_{min})/2$

As shown in Figure 5(c), the effects of increased areas 41 and 42 compared with the luminance level of defect-free area, seem to be smaller than the effect of defect area 40 compared with the luminance level of defect-free area. Therefore, calculated from the above-shown formula, the majority of defect-free pixels will have their luminance levels higher than the Second IR luminance level. Accordingly, it becomes possible to obtain a reference value that reflects the luminance levels of most defect-free pixels.

[0085] At S431, host computer 1 selects a pixel from IR image data, At S 432, host computer 1 determines whether the selected pixel's IR luminance level is higher than the Second IR luminance level. If the IR luminance level is higher than the Second IR luminance level, the process proceeds to S433. If the IR luminance level is lower than the Second IR luminance level, the process moves to S435.

[0086] At S433, host computer 1 adds the IR luminance level of the pixel selected at S431 to variable S. In S434 next, add 1 to variable n. At S435, host computer 1 determines whether the process of S431—S434 has been performed on all the pixels. If host computer 1 determines that the process on all the pixels has not been completed, it returns the process to S431. If it determines the completion of the process on all the pixels, the process proceeds to S436. At S436, host computer 1 calculates for the average value S/n, and the value obtained is stored in memory 1b as the First IR luminance level.

[0087] At S437, flag F3 is set to 0. At S438 next, host computer 1 sent to image reader 2 the calculated accumulation time data for Tr, Tg, Tb and Tir with a main scan start instruction. Image Reader 2 then performs the main scan to read the image. Host computer

1 then proceeds to S439, and waits until the transmission of the main scan image data from image reader is finished.

[0088] When host computer 1 has completed the reception of the main scan image data from image reader 2, it determines YES in S439, and then proceeds to S440. At S440, it selects the pixels of the mth block out of all pixels. In S441—S447, host computer 1 aligns the defect position with the corresponding mth block R image data.

[0089] Illustrated in Figures 18—21 are the processes of defect alignment. Assume that the First IR luminance level calculated in S 436 is "240." In Figure 18 (a), hatched pixels represent decrease in IR luminance level due to the presence of defects. The surrounding pixels have increased IR luminance levels. Their IR luminance levels are higher than the First IR luminance level. Shown in Figure 18(b) are the R luminance levels of R image data block corresponding to the block shown in Figure 18(a). Here the presence of defects is shown. On the other hand, Figure 18(c) shows the R luminance levels of corresponding block where there are no defects. In other words, Figure 18(c) is a diagram, which shows the R luminance levels after a correction process, has been performed.

[0090] In S441, host computer 1 selects a block out of R image data blocks, which corresponds to the previously selected mth block of IR image data within ±3 pixels. Shown in Figures 19—21 are the 3 by 3 (3x3) pixel block whose position is shifted vertically or horizontally by one pixel each time. In S442, host computer 1 carries out the calculation of (R luminance level of the selected nth block pixel) – (IR luminance level of the mth block pixel) to obtain the subtraction value (R)n. For example, in Figure 19 "A-1" the 3x3 pixels bordered with a broad line corresponding to the block in Figure 18(b) is the nth block. In the block surrounded by a broad line in Figure 19 "A-1", the subtraction values for the first row "-45" "-45" "90" can be calculated respectively by "-45=200-245", "-45=200-245" and "90=210-120".

[0091] In S443, host computer 1 totals the absolute values which has bee calculated pixel by pixel from the subtraction described above to obtain the grand total (R)n for the 3x3. In Figure 19 "A-1", the total for the first line subtraction values is "180". The second line total is "340", and the third line total is "411". The grand total for the block is 931. In S444, host computer 1 records in memory 1b the total of subtraction values (R)n calculated in S443. In S445, host computer 1 determines whether the 3x3 pixel block, shifted by one pixel each time vertically and horizontally to calculate the total of subtraction values, has repeated the operation for 49 times or not. If the response is NO, the process is returned to S441. In Figure 19 "A-2" and "A-3", and In Figure 20 "B-1", "B-2", and "B-3", and in Figure 21 "C-1", "C-2" and "C-3" also, the same process is repeated.

[0092] If host computer 1 determines YES at S445, it proceeds to S446 to select the minimum total value (R)n.min. In Figures 19—21, Figure 20 "B-2" block, in which (R)n is "530", is selected. In S447, host computer 1 specifies the block corresponding to $(R)n._{min}$ (Figure 20 "B-2") to be the block corresponding to the IR image data mth block (Figure 18(a)). In S448, host computer 1 selects one pixel out of the mth block (Figure 18(a)).

[0093] In S449, whether the IR luminance level of the selected IR pixel is higher than the Third IR luminance level or not is determined. Host computer 1 determines YES at S449 if the IR luminance level of the selected IR pixel is the same or higher level of the Third IR luminance level , and then proceeds to S450. At S450, (First IR luminance level)/(IR

luminance level of corresponding pixel) is calculated to obtain correction factor. At S451, host computer 1 performs the calculation of {Corrected R luminance level }= (R luminance level of the corresponding pixel) x (correction factor). In S452, host computer 1 records the corrected R luminance level obtained in S451 in memory 1b.

[0094] If S449 determination is NO, that is, if the IR luminance level of the selected IR pixel is lower than the Third IR luminance level, host computer 1 proceeds to S453 and calculates the R luminance level of the corresponding R pixel from the peripheral R luminance levels. In S454, host computer 1 records the calculated R luminance level in memory 1b, and proceeds to S455.

[0095] At S455, host computer 1 determines whether process on all the pixels of the mth block has been finished or not. If the decision at S455 is No, the process returns to S448, and the same process is performed on the next pixel. If the determination at S445 is YES, the process proceeds to S456, and the host computer 1 determines whether the process on all the blocks of R image data has been completed or not.

[0096] If the determination at S456 is NO, host computer 1 returns to S440, makes block selection, and perform the same process on R image data. If the determination at S456 is YES, host computer 1 proceeds and performs S457 process. Shown from S457 through S473 is the process on G image, while the process on B image data is shown from S474 through S491. Because these processes are similar to the process on R data (shown in S440—S456), their explanation is omitted here.

[0097] If the determination at S491 is YES, host computer 1 proceeds to S492 and determines if the mounted film original is a positive film or no. The user can set the type of the original film 26 whether it is a positive film or a negative film by operating the input device for host computer 1. If the determination of S492 is YES, host computer 1 proceeds to S493 to determine whether the user has set up the tone gradation conversion or not. If the answer at S493 is YES, host computer 1 proceeds to S494 to perform the gradation conversion process for R, G, and B data. If the determination at S493 is YES, host computer 1 skips S494 process and proceeds to S495.

[0098] At S495, host computer 1 outputs digital image data to display the image. If the determination at S492 is NO, host computer 1 proceeds to S496, and decides whether the gradation conversion has been set. If the decision at S496 is YES, host computer 1 merges the Set Gradation Conversion Function with the Gradation Inversion Function at S497, and then proceeds to S494. If the decision at S496 is NO, host computer 1 set the Gradation Inversion Function as Set Gradation Conversion Function at S498 and then advance to S494.

[0099] The process performed after S494 is the same as the process described above. Therefore, the description of the process will be omitted here.

(B) Image Reader's Image-reading Operation

The flowchart in Figure 22 starts with S410 prescan start instruction, S425 preview scan start instruction, or S438 main scan start instruction. In this embodiment, image reader 2 performs frame sequential image reading.

[0100] Steps S129 through S136 represent a process related to R image data. Process from S137 to S143 relates to G image data. Process from S144 to S150 relates to B image data. Process from S151 to S157 relates to IR image data. The process relating to R image data will be described below. At S129, CPU 11 controls motor drive circuit 12 to move original holding base 32 in the vertical scan direction to the read start position. At S130, CPU 11 controls motor drive circuit 28 to move film original 26 in the optical axis direction to R position. The R position is a point at which the red component of film original 26 images itself on line sensor 18. At S131, CPU 11 starts R-LED to emit light.

[0101] At s132, CPU 11 starts driving line sensor 18, and keeps driving it for an accumulation time Tr at a predesignated timing. If host computer 1 has not set accumulation time Tr, CPU 11 uses a predesignated accumulation time to drive line sensor 18. At S133, CPU 11 sent host computer 1 one line of R image data it has read.

[0102] Next, at S134, CPU 11 controls motor drive circuit 12 to move original holding base 32 by one line in the vertical scan direction. At S135, CPU 11 determines whether the read-out of the predesignated number of lines has been finished or not. Host computer 1 has set the predesignated number of lines. If the determination at S135 is NO, CPU 11 then performs the process of S133 and S134. If the determination at S135 is YES, it means that the R image data have been acquired. Accordingly, CPU 11 turns off R-LED at S136. CPU 11 also stops the driving of line sensor 18.

[0103] The process related to G image data will be described below. At S137, CPU 11 controls motor drive circuit 28 to move the optical axis direction position of film original 26 to G position. G position is a point at which the green component of film original 26 images itself on line sensor 18. At S138, CPU 11 makes G-LED emit light. At S139, CPU 11 starts to drive line sensor 18. Line sensor is kept being driven for accumulation time Tg at a predesignated timing. If host computer 1 has not set up accumulation time Tg, CPU 11 drives line sensor 18 at a predesignated accumulation time. At S140, CPU 11 reads one line of G image data and sends them to host computer 1.

[0104] At S141, CPU 11 controls motor drive circuit 12, and moves original holding base 32 by one line in the vertical scanning direction. At S142, CPU 11 determines whether the reading of the information about the set number of lines has been finished or not. If the answer at S142 is NO, CPU 11 then performs the process of S140 and S141. If the answer at S142 is YES, it means that the acquisition of G image data has been finished, and then CPU 11 turns light off of G-LED at S143. In addition, CPU 11 stops driving line sensor 18.

[0105] The process related to B image data will be described below. At S144, CPU 11 controls motor drive circuit 28 to move film original 26 in the optical axis direction to a point of B position. B position is a point at which the blue component of film original 26 will be imaged on line sensor 18. At S145, CPU 11 makes B-LED emit light. At S146, CPU 11 starts the driving of line sensor 18. Line sensor 18 is kept being driven for accumulation time Tb at a predesignated timing. In case host computer 1 has not set up accumulation time Tb, line sensor 18 is driven at a predesignated accumulation time. At S147, CPU 11 reads one line and sends its B image data to host computer 1.

[0106] At S148 next, CPU 11 controls motor drive circuit 12 to move original holding base 32 by one line in the direction of vertical scanning direction. At S149, CPU 11 determines whether the reading of the designated number of lines has been finished or not. If the

determination at S149 is NO, CPU 11 performs the process of S147 and S148. If the determination at S149 is YES, it means the acquisition of B image data has been finished. CPU 11, accordingly, turns off B-LED at S150. In addition, CPU 11 stops the driving of line sensor 18.

[0107] The process related to IR image data will be described below. At S151, CPU 11 controls motor drive circuit to move film original 26 in the optical axis direction to the IR position. The IR position is a point at which the IR component of film original 26 images itself on line sensor 18. At S 152, CPU 11 starts the light emission from IR-LED. At S153, CPU 11 starts driving line sensor 18. Line Sensor 18 is kept being driven for accumulation Tir at a designated timing. If host computer 1 has not accumulation time Tir, CPU 11 drives line sensor 18 at a designated accumulation time. At S154, CPU 11 reads one line and sends the IR image data on the line to host computer 1.

[0108] At S155 next, CPU 11 controls motor drive circuit 12 to move original holding base 32 by one line in the direction of vertical scan direction. At S156, CPU 11 determines whether reading of the set number of lines has been finished or not. If the determination at S156 is NO, CPU 11 performs the process for S154 and S155. If the determination at S156 is YES, it means the completion of the IR image data acquisition. Accordingly, CPU 11 turns off I-LED at S157. CPU 11 also stops driving of line sensor 18 at S158, and finishes the process for this flowchart.

[0109] CPU 11, performing frame sequential reading, read R image data going and G image data on return, and reading B image data going and IR image data on return. Now, the second embodiment of the present invention will be explained below. The difference between the first embodiment and the second embodiment is observed in the replacement of Figure 10 flowchart process with Figure 26 flowchart. Other processes of the second embodiment are identical with those of the first embodiment. Therefore, the rest of the second embodiment will not be described below.

[0110] Shown in Figure 26 is a part of the second embodiment flowcharts. The program shown in Figure 26 flowchart is stored in CD-ROM 3 so that it can be set up in host computer 1. The program set up is stored in HDD 1c. The program is read into memory 1b, and in this state it is used by CPU 1a.

[0111] With reference to Figure 26 flowchart, the second embodiment will be explained below. At S525, host computer 1 sends to Image Reader 2 the calculated data for accumulation times Tr, Tg, Tb and Tir, and a preview scan start instruction. Image Reader 2, accordingly, performs image read out by preview scanning. In S526 next, host computer 1 waits until image reader 2 has finished the transmission of all the preview image data.

[0112] After the completion of the reception of the preview scan image data from image reader 2, host computer 1 decides YES at S526, and proceeds to S527. At S527, host computer 1 displays on the screen the image based on the digital image data it has received. In S528, host computer 1 sets a threshold value (Second IR luminance level), which is outside the range of IR luminance level scattering caused by the differences in film and subject types. It is then established that the pixels below the Second IR luminance level should not be used in the calculation for the First IR luminance level. The specific procedure for determining the second IR luminance level is as follows.

[0113] First, out of the IR image data received in S526 process, the maximum luminance level IR_{max} is detected. Next, out of IR image data received in process S526 the minimum luminance level IR_{min} is detected. Then, from the following formula, the Second IR luminance level is calculated:

$$\text{Second IR luminance level} = (IR_{max} + IR_{min})/2$$

By using the above obtained Second IR luminance level, it becomes possible to obtain a reference value, which reflects the luminance levels of the majority of defect-free pixels.

[0114] At S529, each H(L) is initialized to 0. H(L) shows the number of pixels with L IR luminance level. For example, H(0) indicates how many pixels with IR luminance level 0 are present. Next, in S531—S536, the IR luminance level (the First IR luminance level) to be used as reference value is calculated. The First IR luminance level should be close to the IR luminance level for a defect-free case. In this case, it is assumed that the area with defects is small in the original. On the basis of this assumption, the most frequent IR luminance level is calculated as the First IR luminance level.

[0115] In S531, host computer 1 selects one pixel out of IR image data. In S532, host computer 1 determines whether the IR luminance level of the selected pixel is at or higher than the Second IR luminance level. If IR luminance level is at or higher than the Second IR luminance level, the process proceeds to S533. If the IR luminance level is lower than the Second IR luminance level, the process proceeds to S535.

[0116] At S533, host computer 1 determines the IR luminance level L of the pixel selected in S531, and adds one to H(L). At S535, host computer 1 determine whether the steps S531—S533 have been performed on all the pixels. If it was decided that the steps have not been finished on all the pixels, the process returns to S531. If it is decided that all the pixels have gone through the steps, the process moves to S536. In S536, host computer 1 detects the L at which H(L) attains the maximum value, and stores the L in memory 1b as the First IR luminance level.

[01117] At S537, flag F3 is set at 0.

[01118]
[Advantages of the Invention] With the unit of the present invention, the acquisition of an image is assured with effects of the defects on the transparency original having been corrected. Especially because this correction means performs the correction process by applying the correction factor calculated by the correction factor-calculating means to both the first area visible component level and the second area visible component level, no correction irregularities are produced in the correction of the First area and the Second area.

[Brief Explanation of Drawings]

[Figure 1] A structural diagram of the image processing unit for the first embodiment

[Figure 2] A diagram showing the arrangement of the film original

[Figure 3] A flowchart for the original detection process procedure for CPU 11 to perform

[Figure 4] A flowchart for the original detection process procedure for CPU 11 to perform

[Figure 5] A drawing illustrating digital image data

[Figure 6] A chart for illustrating the principle of digital image data-correcting process

[Figure 7] A chart for illustrating the principle of digital image data-correcting process

[Figure 8] A correction process procedure flowchart for the host computer

[Figure 9] A correction process procedure flowchart for the host computer

[Figure 10] A correction process procedure flowchart for the host computer

[Figure 11] A correction process procedure flowchart for the host computer

[Figure 12] A correction process procedure flowchart for the host computer

[Figure 13] A correction process procedure flowchart for the host computer

[Figure 14] A correction process procedure flowchart for the host computer

[Figure 15] A correction process procedure flowchart for the host computer

[Figure 16] A correction process procedure flowchart for the host computer

[Figure 17] A correction process procedure flowchart for the host computer

[Figure 18] A diagram illustrating the alignment process.

[Figure 19] A diagram illustrating the alignment process

[Figure 20] A diagram illustrating the alignment process

[Figure 21] A diagram illustrating the alignment process

[Figure 22] A flowchart for process procedure to be performed by CPU 11

[Figure 23] A flowchart for process procedure to be performed by CPU 11

[Figure 24] A flowchart for process procedure to be performed by CPU 11

[Figure 25] A flowchart for process procedure to be performed by CPU 11

[Figure 26] A flowchart for process procedure to be performed by the host computer

[Explanation of Reference Numerals]

1 Host computer
1a Central processing unit (CPU)

1b	Memory
1c	Hard disk drive (HDD)
2	Image reader
3	Storage medium (CD-ROM)
11	Central processing unit (CPU)
12	Motor drive circuit
13	LED drive circuit
14	Signal processing circuit
15	ROM
16	RAM
17	Interface circuit (IF circuit)
18	Line sensor
19	A/D converter
20	Vertical scanning mechanism motor
21	Lighting unit
22	Reflective mirror
23	Reflective mirror
24	Toric mirror
25	Lens
26	Film original
26a	Film original section
26b	Film mount section
27	Focus-adjusting motor
28	Motor drive circuit
29	Vertical scanning mechanism
30	Focus-adjusting mechanism
32	Original holding base
33	Film holding spring
34	Optical plane (see-through) section
35	Optical axis
70	Dust
P	Lighting point

[Figure 1] A structural diagram of the image processing unit in an embodiment

Vertical scanning direction

[Figure 2]

[Figure 3]
Start

S1 Move read point to X0

S2 Determine an accumulation time at which A/D converter output can be in full scale

S3 Move read point to X1

S4 Read 1 line

S5 Calculate the average value L1 of a line

S6 Compare L1 with threshold L3

S7 L1>L3

S8 F1=0

S9 F1=1

S10 Reset elapsed time and starts measuring elapsed time

[Figure 4]

S11 Instruction form host computer received?

S12 Has elapsed time reached the designated limit?

S13 Is the instruction a query if a film mounted

S14 Analyze the instruction content

S15 Execute the process in response to the instruction

S16 ? 1=C

S17 Send message to host computer to tell that film is not mounted

S18 Send message to host computer to tell that film is mounted

S19 Unit power source turned off?

End

[Figure 5]

[Figure 6]

[Figure 7]

[Figure 8] A correction process procedure flowchart for the host computer

Start

S401 Ask scanner if a film has been mounted

S402 Is film present?

S403 Has user issued a scan instruction?

S404 F2=0 ?

S405 F2=1

S406 F3=1

S407 F3=1 ?

S408 F2=0

[Figure 9] A correction process procedure flowchart for the host computer

S410 Send prescan start instruction to scanner

S411 Has image data reception from scanner completed?

S412 Detection of Rmax, Cmax and Dmax

S413 Is the film a positive film?

S414 Calculate the visible light max from Rmax,, Cmax and Bmax

S415 Calculate (RGB scale factors=255/visible light max)

S416 Detect IRrmax

S417 IR scale factor=255/IRmax

S418 Resetting the accumulation time
Tr=Tr' x RGB scale factor
Tg=Tg' x RGB scale factor
Tb=Tb' x RGB scale factor
Tir=Tir' x IR scale factor

S419 Calculate R scale factor = 255/Rmax

S420 Calculate G scale factor = 255/Gmax

S421 Calculate B scale factor = 255/Bmax

S422 Detect IRrmax

S423 Calculate IR scale factor = 255/IRmax

S424
Resetting the accumulation time
Tr=Tr' x R scale factor
Tg=Tg' x G scale factor
Tb=Tb' x B scale factor

Tir=Tir' x IR scale factor

[Figure 10] A correction process procedure flowchart for the host computer

S425 Send scanner Tr, Tg, Tb, and Tir data and a preview scan start instruction

S426 Is the preview scan image data reception complete?

S427 Display preview image

S428 S=0

S429 n=0

S430 Calculate for the Second IR luminance level

S431 Select 1 pixel out of IR data

S432 IR luminance level ≥ Second IR luminance level

S433 S = S + IR luminance level

S434 n = n + 1

S435 All pixels processed

S436 First IR luminance level = S/n

S437 F3 = 0

[Figure 11] A correction process procedure flowchart for the host computer

S438 Send scanner Tr, Tg, Tb and Tir data and a main scan start instruction

S439 Is the reception from scanner of the main scan image data complete?

S440 Select the mth block pixels of all the IR pixels

S441 Select a block out of corresponding mth block of R image data in which there are shifts of ±3 pixels and less.

S442 Subtraction value (R)n = nth block R luminance level – mth block IR luminance level

S443 Total (R)n = Σ (absolute value for subtraction value (R))

S444 Record total value (R)n in memory

S445 n = 49 ?

S446 Select the total value (R)n.min, the minimum value of the total values (R)n

[Figure 12] A correction process procedure flowchart for the host computer

S447 Specify the block corresponding to total value (R)n.min as the mth block

S448 Select a pixel from IR image data's mth block

S449 IR luminance level ≥ Third IR level

S450 Correction factor = First IR luminance/IR luminance level

S451 Corrected R luminance level = R luminance of the corresponding pixel x Correction factor

S452 Record the corrected R luminance level in memory

S453 Calculate the R luminance levels of the corresponding pixels from the peripheral R luminance levels

S454 Record the calculated R luminance level in memory

[Figure 13] A correction process procedure flowchart for the host computer

S455 All the pixels in the mth block processed?

S456 All the blocks processed with regard to R image data?

S457 Select the pixels of mth block out of all the IR pixels

S458 Select a block out of blocks of the mth block of corresponding G image data in which there are shifts of ±3 or less.

S459 Subtraction value (G)n = nth block G luminance level – mth block IR luminance level

S460 Total value (G)n = Σ (absolute value of subtraction value (G))

S461 Record Total value (G)n in memory

S462 n = 49 ?

S463 Select the total value (G)n.min, the minimum value of total values (G)n

[Figure 14] A correction process procedure flowchart for the host computer

S 464 Specify the block that corresponds to total value (G)n.min as the mth block

S465 Select a pixel from the mth block of IR image data

S466 IR luminance level ≥ Third IR luminance level

S467 Correction factor = First IR luminance level/IR luminance level

S468 Corrected G luminance level = G luminance level of the corresponding pixel x correction factor

S469 Record the corrected G luminance level in memory

S470 Calculate the G luminance level of corresponding pixel from the peripheral G luminance levels

S471 Record the calculated G luminance level in memory

[Figure 15] A correction process procedure flowchart for the host computer

S472 All the pixels in the mth block processed?

S473 All the blocks processed with regard to G image data?

S474 Select the pixels of the mth block out of all the IR pixels

S476 Select a block out of the blocks of corresponding B image data's mth block with ±3 or less shifts.

S477 Subtraction value (B)n = nth block B luminance level – mth block IR luminance level

S478 Total value (B)n = Σ (absolute values of subtraction values (B))

S479 Record total value (B)n in memory

S480 n = 49 ?

S481 Select total value (B)n.min, the minimum value of total values (B)n

[Figure 16] A correction process procedure flowchart for the host computer

S482 Specify the block corresponding to the total value (B)n.min as the mth block

S483 Select a pixel from the mth block of IR image data

S484 IR luminance level ≥ Third IR luminance level

S485 Correction factor = First IR luminance level/IR luminance level

S486 Corrected B luminance level = B luminance level of corresponding pixel x correction factor

S487 Record the corrected B luminance level in memory

S488 Calculate the B luminance level of corresponding pixel from the peripheral B luminance levels

S489 Record the calculated B luminance level

[Figure 17] A correction process procedure flowchart for the host computer

S490 All the pixels in the mth block processed?

S491 Have all the blocks been processed with regard to B image data?

S492 Is the film a positive film?

S493 Has the user set up the gradation conversion?

S494 Perform gradation conversion processes on R, G, and B data

S495 Output image data to the display

S496 Has the user set up gradation conversion?

S497 Merge the set gradation conversion function with the gradation inversion function

S498 Set the gradation inversion function as the set up gradation conversion function

End

[Figure 18] Illustration of an aligning process

(a) IR levels (with defects)
(b) Visible levels (with defects)
(c) Visible levels (defect-free)

[Figure 19] Illustration of an aligning process

Total of absolute values
Grand total

[Figure 20] Illustration of an aligning process

Total of absolute values
Grand total

[Figure 21] Illustration of an aligning process

Total of absolute values
Grand total

[Figure 22] A flowchart for the scanner process procedure

Start

S129 Move the original in the vertical scanning direction to the read out start position

S130 Move the original in the optical axis direction to R point

S131 Light emission from R-LED

S132 Start driving the line sensor

S133 Send R image data to host computer

S134 Shift the original by 1 line in the direction of vertical scanning direction

S135 Has the process of set number of lines finished?

S136 Turn off R-LED

[Figure 23] A flow chart for scanner process procedure

S137 Move the original in the optical axis direction to G point

S138 Light emission from G-LED

S139 Driving of line sensor starts

S140 Send G image data to host computer

S141 Shift the original in the vertical scanning direction by 1 line

S142 Has the process of set number of lines finished?

S143 Turn off G-LED

[Figure 24] A flowchart for scanner process procedure

S144 Move the original in the optical axis direction to B point

S145 B-LED emits light

S146 Driving of line sensor starts

S147 Send B image data to host computer

S148 Shift the original in the vertical scanning direction by 1 line

S149 Has the process of set number of lines finished?

S150 Turn off B-LED

[Figure 25] A flowchart for scanner process procedure

S151 Move the original in the optical axis direction to IR point

S152 IR-LED emits light

S153 Driving of line sensor starts

S154 Send IR image data to host computer

S155 Shift the original in the vertical scanning direction by 1 line

S156 Has the process of set number of lines finished?

S157 Turn off IR-LED

S158 Stop driving line sensor

END

[Figure 26] A flowchart for host computer process procedure

S525 Send scanner Tr, Tg, Tb and Tir data and a preview scan start instruction

S526 Preview scan image data reception complete?

S527 Display the preview image

S528 Calculate for Second IR luminance level

S529 H(0) = 0 : H(maximum luminance level) = 0

S531 Select a pixel out of IR data

S532 IR luminance level L ≥ Second IR luminance level

S533 H(L) = H(L) + 1

S535 Process of all the pixels completed

S536 The L at which First IR Luminance level = H(L) is maximized

S537 F3 = 0

Figure 1 Structure of the image processing unit for an embodiment

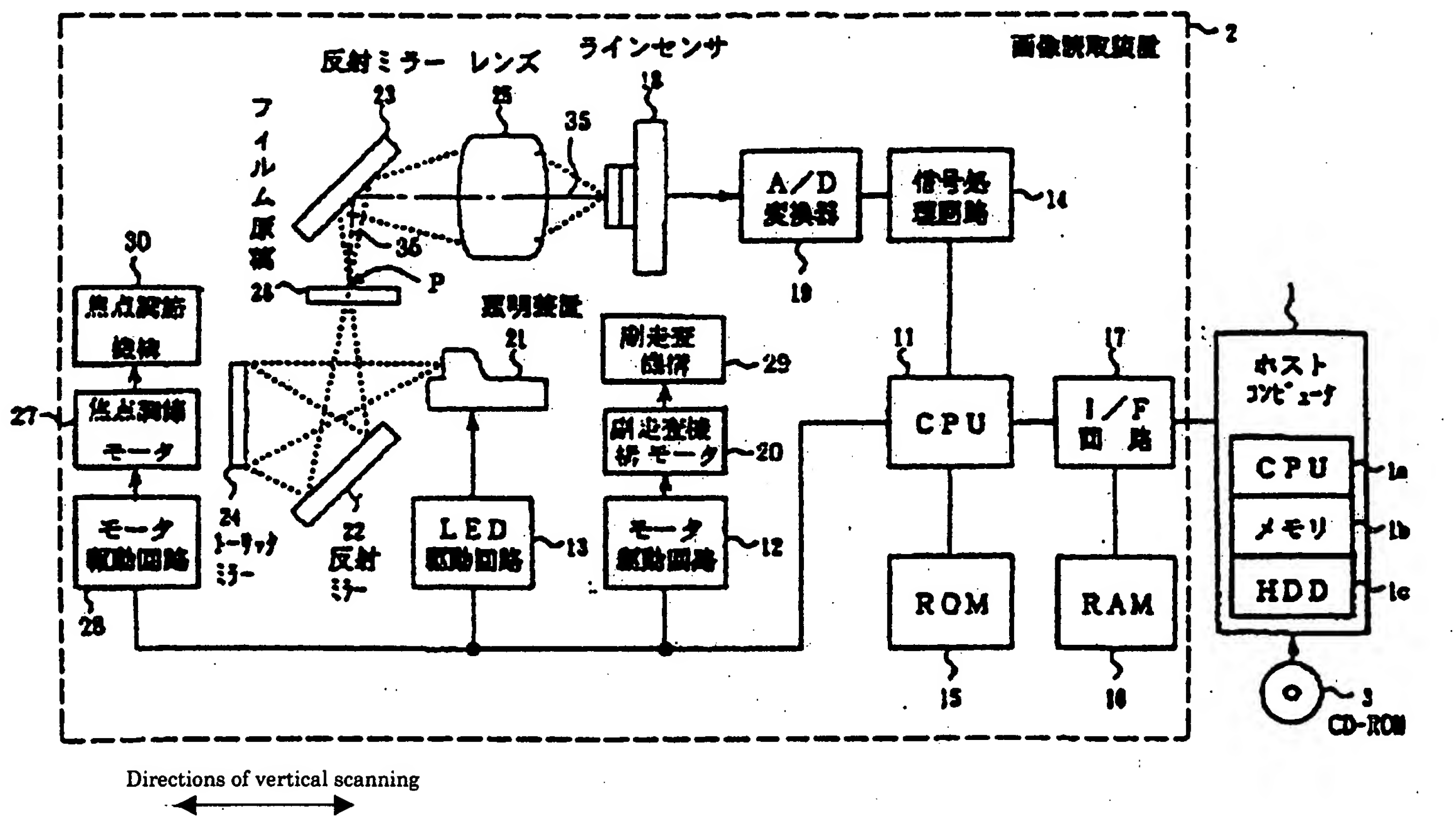
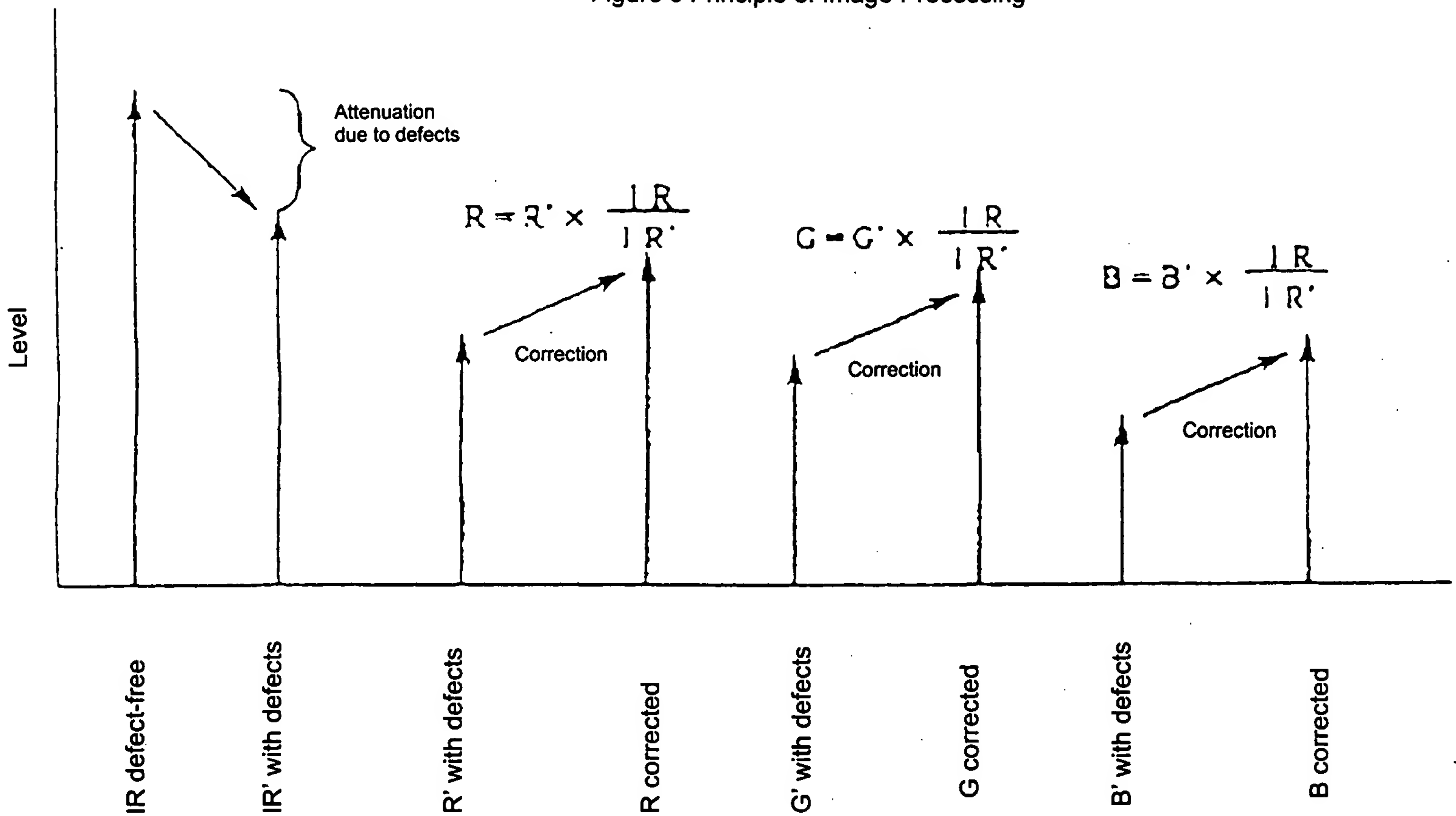


Figure 6 Principle of Image Processing



IR (infrared light), R (red light), G (green light), B (blue light)

Figure 7 Principle of Image Processing